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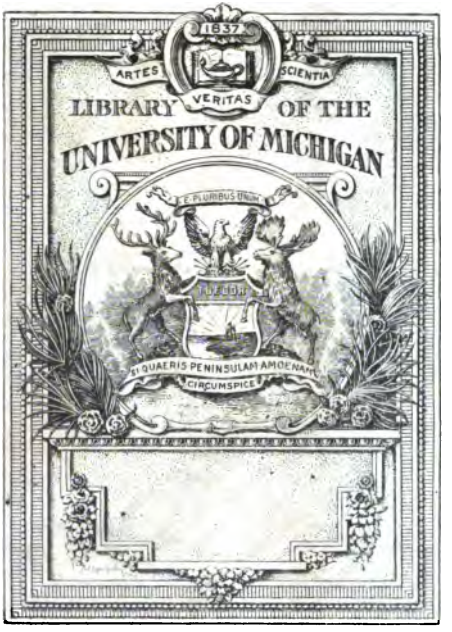
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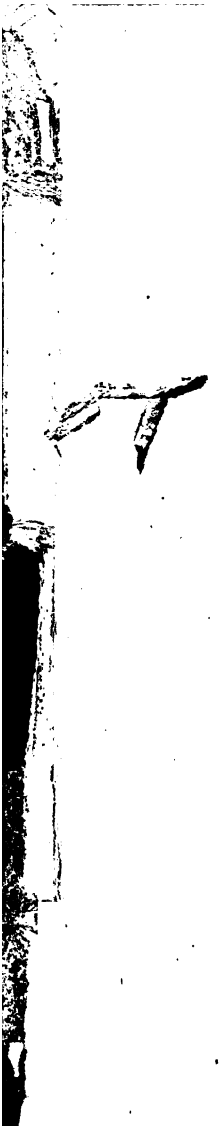

PRACTICAL MINING.

38813

A Field Manual for Mining Engineers.

WITH HINTS TO INVESTORS IN MINING PROPERTIES.

BY

JOHN G. MURPHY, E. M.

NEW YORK:
D. VAN NOSTRAND COMPANY,
23 Murray and 27 Warren Streets.
1890.

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PREFACE.

THE percentage which is realized from an investment is governed to some extent by the nature of the security. If it is such as is not liable to much fluctuation, it is sought for permanent investment, even at a low rate of interest. Generally we may say: The profit to be expected from any investment should be commensurate with the risk taken. People who are glad to realize 5 per cent on real estate will expect to realize 25 to 30 per cent, and often more than this amount, on a mining venture, as it is called; and it must be admitted that it is not too much for a purchaser of mining-stock to expect under existing conditions: but the intelligent operator, not in mining stock but in mines, will be satisfied with less. Naturally, a mining investment should be expected to pay a much higher rate of interest than real estate or railway securities, because it is less permanent.

The chief cause of the uncertainty in mining ventures, however, is the fact that the most of those offered to the public are not expected to be productive for any length of time, if at all. To get an accurate idea of the mining industry would require severe study and time, so that the majority of operators prefer to pay for obtaining the necessary knowledge, and success or failure is chiefly due to the value of this purchase. The following pages are written at the request of friends, with the purpose of pointing out as briefly as possible the nature of the knowledge to be sought, and by exposing some of the sources, to limit the frequency of error.

J. G. MURPHY.

NEW YORK, December, —, 1889.

PRACTICAL MINING.

THE relation between mines and location is of such vital importance that the engineer must consider them together. This will become apparent on reflection, and it is the design of this brief work to show that a careful investigation of both should be made by the consulting engineer before he renders a decision. Mining operators generally imagine that a knowledge of the subject, coupled with a superficial examination, is all that is needed—a mistake that has occasioned severe loss. The intelligence of the examiner and the amount of care and thought devoted to each examination have more to do with the value of his judgment than knowledge of the subject. Many people think that when an engineer has examined a mine, sampled the ore and had it assayed, and reported upon its quality, his work is completed. But is his work really com-

pleted? I think not; for a buyer should have some idea of how much a given mine will pay in order to estimate its value from a commercial standpoint. Eastern capitalists have often labored under the delusion that a needy relative or friend who has failed in the ordinary vocations of life—a son or nephew just out of school—are fitted for mining managers; and it is a source of regret to people who take a deep interest in the mining industry when such persons are employed in that capacity. In many cases these managers have first erected a fine residence, then secured a four-in-hand at the expense of the company by whom they were employed, before the mine began to pay. Ordinary business prudence would suggest living in a log-hut and visiting on foot until the mine becomes productive, after which he may discover that it will tax his intelligence and ingenuity to learn how much it can be made to pay. When the discovery is made, he will find that there is little use for a four-in-hand.

I have heard it said repeatedly that the mine makes the man, and there is some

truth in the remark with respect to public reputation; but I have known the man to make the mine and earn his reputation. I could cite many instances of mines rescued from financial failure by the substitution of competent for incompetent management. It is the aim of this work to consider the department of an examining engineer rather than that of a mining manager; though the two departments cannot be entirely separated. The thoughtful reader will doubtless reach the conclusion that competency in either department requires a broad technical education, extensive experience, coupled with patience and vigilance.

In making an examination of a mine, the amount of the dividends being paid, or which can be paid, and the length of time any property will pay a given amount, are the uncertain factors the examiner must have constantly in mind. It is more difficult in general to learn what a mine is paying than what it may be made to pay. The mining and metallurgical operations may be carried out to perfection; there remains the commercial question, in which

the owners are solely interested. Can we have larger dividends by the employment of other methods than those in use? It is to the solution of this question that the engineer must devote the knowledge acquired by large experience, and neither more nor less than this his client should expect of him. He should not only consider well-known methods, but also the improvements which have been made upon them to fit special conditions, and their adaptability to the conditions under examination. In the Black Hills of Dakota, for example, we find two systems of mining employed: 1st, Open cut or quarry work; 2d. Underground mining, and timbering by square sets to sustain the roof. The ore body of that section is covered by a porphyry overflow, varying from 15 to 100 feet in thickness. The first system employed was underground work and timbering; but later it was found cheaper to blast and remove the capping where it was not too thick, and then extract the ore by open cut. About six years ago the superintendent of the Father de Smet Mine tore down 2500 tons of ore at a single

open-cut blast by exploding a series of deep drill-holes by the battery. This method has the advantage of greater safety, and its employment should only be limited by commercial considerations.

In the mining department very careful attention is due to the method of attack and to the selection of the most available point for extensive work, for economy of transportation and dumpage, except in the case of prospects, when the ore should be followed until the stability of the vein is proved. The question of transportation and the facilities offered for the employment of metallurgical operations are those which, upon the whole, demand the most attention. Very often success or failure will depend upon them.

For convenience, ores may be divided into (*a*) Free-milling, (*b*) Refractory, (*c*) Free-milling and Refractory combined. This work will be confined to a consideration of the ores of gold and silver which have commercial importance. To (*a*) belong native gold, native silver, and the chloride of the latter.

In the examination of native gold, in

quartz or other rock, the average width should be determined as nearly as possible. A mill-run of 100 or more tons should be made to determine the average value of the ore. But before incurring such an expense, however, preliminary tests should be made by pan and by assay, care being taken to obtain average samples by cross-sectioning the vein: such tests may lead to the rejection of the mine without further expense. Should these tests be favorable, then the mill-run should be made before rendering a final decision. Free-milling gold ores are exceedingly variable, even in the same mine, so that too much care cannot be employed.

After determining the width of vein or pay-streak, and the average value of the ore, it is necessary to see if there is available water. How much? How near? What will it cost to bring it in? How much would it cost per ton to transport the ore to the water? Is there timber available for mining purposes and for fuel? Considering the water and timber questions together, is it preferable to bring in the water or transport the ore to the water?

If the mine is wet, what will be the cost of a pumping plant of sufficient capacity? This estimate should be made with some regard to future as well as present requirements. What will be the cost of a hoisting plant, regard being had for future requirements, to raise a given number of tons? The cost of labor is known, and the wear and tear can be closely approximated. We can now make our balance sheet. Charge Blacksmith-shop account, Carpenter-shop account, Mine Timber account, Pumping and Hoisting account, Mine Transportation account, Mine Timbering account, Mine Supplies account (Powder, Fuse, Caps, Candles, etc.), to Mining account. Charge Mining account, Transportation account, Mill Supplies account, to Mill account. Charge Mill account, Office account, Insurance account, Interest account, Express account, Taxes account, Salary account, Law account, to Bullion account. This is all that is needed for the present. Everything is charged over to Bullion account, the value of which will show whether there has been a loss or a gain, and how much.

It may be said that all of this is not necessary, and unless the mine is in operation, cannot be determined. It must be remembered that well-developed mines with a full plant are sometimes offered for sale. If it is a free-milling ore, every account mentioned should be determined, with perhaps the exception of Law account. If the mine is not equipped, it would be well to estimate all these accounts as nearly as possible for a period of say two months—about the average length of time a set of mill shoes and dies will last. The Bullion value should be estimated by the average obtained from a large test of the 100 tons at least. Suppose it is designed to equip a mine for an output of 50 tons daily: our client can easily calculate what the bullion output should be for two months if he knows the average value of the ore; but he does not know what the equipment will cost, nor does he know the cost of the operations outlined herein. Let them be enumerated, and he will see that he must have blacksmith- and carpenter-shops, a pumping and hoisting plant, mine tracking, mine supplies, an outer tramway

from mine to mill, a mill, mill supplies, etc. If the operator knows his engineer well, he may not wish for these details; but he does not always know him, and, having these estimates, he can submit them to others for *verification.*

The purchase of a mine and its equipment is a serious matter, and it must be expected that the purchaser will make close inquiry; he should, therefore, be furnished with the means to make it. It is evident that a mine manager should keep all of these accounts, and, if he is careful, in addition thereto, Shaft account, Tunnel account, Improvement account. Then by reference to his books he can see what each piece of work costs, and if he knows his business he has a check on the men. The foreman of any special job should render his account when his shift is over. Suppose the night and the day shifts consist of an equal number of men, and that the day shift breaks 12 carloads more than the night shift: the Transportation account should be made to show this, and then we know that there is something wrong. Suppose, also, that the books

show that the cost of sinking a shaft is $12 per foot, of driving a tunnel $7 per foot. A man may be found who will do the work under contract fully as well for $10 and $5.50, respectively. Let the manager watch every department, and the company can afford to buy him a four-in-hand when he needs it.

We had our bullion (unfortunately on paper) and the cost of its production; the value of the bullion may leave a fair profit. Is the engineer's work now done? Let us see. The capitalist may be well pleased, but nevertheless ask, Is that the best that can be done? We go over our figures again, and show that our addition, multiplication, and division are correct, and, in most cases, our client will be satisfied. It is possible, however, that he may be a mining man, and instead of being satisfied, say, Yes, I see that your addition, multiplication, and division are all right; but how about your subtraction? A very inconvenient question, which means, Cannot the cost be reduced? That is a pertinent question. The ore may be hard or soft, the gold disseminated through it may be

coarse or fine, or it may be both—which is generally the case. If it is hard and massive, the stamp-mill should be employed. How about the screens? Shall we use a 40-, 50-, or 60-mesh = 1600, 2500, or 3600 per sq. in. It is readily seen that the capacity of the mill will vary with the size of screen.

Assume that we are dealing with a $10 ore, and that with a 40-mesh screen we crush 2 tons per stamp, with a saving of 75 per cent of the gross value. With a 20-stamp mill we will realize 20 × 2 × $7.50 = $300 gross value daily. By the use of a 60-mesh screen, it is found in practice that the capacity is a trifle more than one half of what it is with a 40: call it half. A 40-stamp mill is now needed for equal capacity, and it will cost about $15 more per day to run it; but we find the saving to be 85 per cent. Then 40 × $8.50 = $340 − $15 extra cost = $325, as against $300 with the 40-mesh, a difference of $25; but there is the cost of 20 additional stamps to consider. In Western practice, little or no preference would be given in such a case as this; but if we consider the rela-

tive saving of 75 and 85 per cent, there would be. (Our personal experience indicates that if a 40-mesh screen will not give good results, neither will a 60; but others assert the contrary, and it is but fair to suppose that there are ores for which a 60-mesh is preferable.)

The ore may be porous, friable, and easily crushed, like all the gold-bearing porphyry at Farncom Hill, near Breckinridge, Colorado; the District of Sinda, Mexico; and elsewhere. The capacity of the stamp-mill depends more on the rapidity of discharge (size of screens) than the crushing power of the stamps, so that its effectiveness is not increased in proportion to the softness of the ore. We would then employ the Huntington mill, which saves a much higher percentage, especially of fine gold. These mills are now in successful operation on Farncom Hill ore, where the cost of crushing and amalgamation is under 50 cents per ton, and the original cost of a plant, for equal capacity with the stamp-mill, very much less. Ores vary in all degrees between the massive and the friable, so that the most efficient machine

must be determined in each case by a thorough test. In this way we must be prepared to discuss the question of subtraction with our client.

FREE-MILLING SILVER ORES.

With this class of ore fully as much care is required. We cannot use the pan, shovel, or batea for our preliminary determinations. The assay alone must show whether or not the ore is sufficiently rich to justify the expense of a mill test. When the mine is well opened, cross-sections of the vein, or pay-streak, should be taken every 6 to 10 feet, except where bunches of barren rock occur that would be rejected in the ordinary operations of mining, or at places where the vein pinches to such an extent as to make the proportion of barren rock to ore too great. No general rules for sampling can be laid down, the particular conditions in each case must receive careful attention, and the engineer's judgment should be governed accordingly. Crushing, wet or dry, and pan amalgamation with or without settlers, constitute the most approved

method used in the reduction of free-milling silver ores, provided the conditions will admit of its employment. The process is much more expensive than that for free milling gold ore. In the latter the crushing, and also the amalgamation, are done in battery (mortar), aided by the outer copper plates, and the average cost with a fair-sized modern mill will not exceed 75 cents per ton, while with the former the average will reach $4; so that a fair profit might result from the treatment of a free-milling gold ore, while a loss would be sustained with a silver ore of the same assay value. This was signally shown by the costly failures of the Silver Cliff and Plata Verde mines in Silver Cliff, Colorado, and the Game Ridge property near Rosita, Col., where 40-stamp mills were erected at a cost of fully $150,000 per mill. The Silver Cliff mine was operated for a time successfully on $9 to $10 ore, but the Plata Verde and Game Ridge mills were quickly closed when they found that their ore, which only milled $5 to $6 per ton, would not pay the expense of mining, transportation, and milling. The Silver Cliff did not long sur-

vive them, as that ore also became too poor to pay. We do not know who was responsible for the heavy losses sustained by these failures, but we do know that these enterprises were condemned by several engineers whose protests were not heeded.

Large bodies of free-milling gold ore of the above value ($5 to $6) per ton would pay handsomely, however, as shown by the success of the Homestake and other mines in the Black Hills, Dakota, which have paid large dividends on $4.50 to $5.00 ore.

REFRACTORY ORES.

The consideration of this class of ore leads us to the most complex problems of mining and metallurgy as a commercial undertaking, for which the examiner will need all his patience and vigilance. He must put favorite methods under lock and key, to be brought forth again at leisure. Prejudice in favor of approved methods must be laid aside. The conditions of mine, ore, and district under examination are what is needed, and then the application of the system which will give the best commercial results. Fatal mistakes have

been made in the attempt to make the mine and its surroundings fit the process, instead of making the process fit them.

Commercially, we may divide refractory ores into three classes: (*d*) Ores that will pay best by shipment; (*e*) Ores that will pay best by treatment near the mine; (*f*) Ores that will pay best by selecting and shipping a part and treating the remainder at the mine.

We will consider these cases in their order.

If the ore is dry (low in lead), but rich in gold or silver, or both, we may find it in connection with iron or copper pyrites, tellurides of gold and silver, silver glance, dark and light ruby silver, brittle silver, gray copper, etc. Omitting ores which contain a high percentage of copper and the tellurides, we have those which can be smelted with lead ores, or milled by the chlorination and pan amalgamation process. The preference will be given to smelting when possible, because of its closer saving; but in order to smelt we must be located in, or adjacent to, a district where we can obtain a sufficient amount of ore

rich in lead. Failing in this, we must decide between shipping to smelting-works, where rates of transportation, smelting charges, etc., aggregate the smallest cost per ton ; or the milling process above mentioned, at or near the mine.

The value of the ore per ton will determine our choice, which can be seen by the following estimates :

Suppose we are dealing with a $25 ore, and we have figured the cost of mining and delivery at the mill to be $2 per ton ; the cost of crushing, roasting with salt for chlorination, amalgamation, etc., $11 per ton; superintendence, expressage on bullion, insurance, interest on invested capital, etc., $4 per ton of ore: we have a total of $17 per ton, which will be found a fair average cost by this system. If we save 80 per cent of the gross value, it may be regarded as fair work, and we have 80 per cent of $25 = $20 — $17 expense = $3 per ton profit.

In some sections the expense charge of $17 per ton might be reduced somewhat, leaving a little more profit ; but there is an equal liability to a heavier expense account,

with a corresponding reduction in the profit. Now suppose we find the cost of transportation by wagon and railroad to be $8 per ton, the smelting charge $10, and add, say, $2 for incidentals, etc.,—which is but half what was added before, because in this case the ore is sold at the smelter,—we have a total of $22 per ton expense account ($2 per ton being allowed for mining, as before). On an average, 95 per cent of the assay value is allowed by the smelters, and we have 95 per cent of $25 = $23.75 — $22.00 = $1.75 profit. The reader can make his choice, for it is certain that the writer would make no selection in actual practice; for, knowing the liability of ore to fluctuation in value, we would take no chances on the above showing: but suppose that instead of $25, we find the ore to yield $80 per ton—a value that is often reached and even surpassed on the large scale. [When $250 and $300 per ton are talked of on the large scale, there is good reason to suppose that we are being entertained with fairy tales; for the history of mining in the United States, or in any part of the world, does not warrant the

expectation of such values in extensive mining.] At $80 per ton we should have with the mill 80 per cent of $80 = $64 — $17 = $47 per ton profit.

By selling to the smelter, 95 per cent of $80 = $76 — $22 = $54 profit: a difference of $7 per ton in favor of the latter, as well as saving the heavy expense of a mill plant. Here we would have a decided preference, and would be glad to take chances on the above showing.

The value of the ore will have many gradations between the extremes here given. Conditions may vary, rates of transportation and smelting may be higher or lower, so that the choice must be determined for each particular case.

Where the profit is the same, or but slightly in favor of the mill, the preference should be given to shipments, as the amount of the investment, and consequently the risk of our clients, is thereby greatly reduced. If the ore is wet (rich in lead), we must consider the feasibility of erecting a smelter. The district in which the mine is located must now be examined. It may produce a variety of ores, some

wet, others dry, some low in the precious metals, others rich. If our own mine will not supply sufficient ore for a smelter, we may secure enough by previous contract and purchase, selecting wet and dry in proper proportions for our smelting mixture, which should not contain less than 20 per cent lead. We may have a wet ore poor in silver, and still may, by the purchase of dry ores rich in silver, make it pay well by smelting them together.

What we wish to know is: How many tons of ore daily can we control by ownership of mines, how many by contract and purchase? Briefly, how many tons per day can we control that will yield 20 to 25 per cent lead? What will proper fuel cost? What iron and limestone for flux? All must be found in sufficient quantity, and rates be low enough, otherwise we may find it preferable to ship. Ores rich in copper and tellurides of gold and silver must pass through the copper-smelting process, the silver being extracted in subsidiary processes during the operation, such as the Augustine and Ziervogel methods used at Argo (Prof. Hill's) Works,

near Denver, Col. The Argo Works are also reputed to have a secret process for the extraction of the gold from the copper, said to be a device of the superintendent, Mr. Richard Pearce. Whether they use a secret and improved method for parting, or the method by the use of sulphuric acid, is known only to themselves. In any event it is the same to the mine owner; for there are but few districts which will of themselves furnish all the necessary elements of success for a copper-smelting process involving in its operations the extraction of the gold and silver in the ore. Before an engineer recommends such an enterprise to his client, he should spend a year in examining the resources of the district and its vicinity wherein he proposes to establish such works, and two years in thoroughly mastering the various details of the process. But even when all this has been done, he must have a very sanguine temperament if he hopes to compete with the great resources in capital, fixed establishment, and experience of the Argo people. It is not my purpose to discourage honest enterprise, but to enforce the neces-

sity for thoroughness and caution, which are among the elements which create successful competition and promote the general welfare of every industry.

The examining engineer must report on every special mine under existing facts and prices, and rarely finds time to consider such a project as copper-smelting works. The prices at Argo will vary with the character of the ore. On an average the following may be taken as a close approximation: 95 per cent of the gross value of the precious metals is allowed. $2 per unit is paid for all the copper in the ore, after deducting 2 units; that is, if an ore contains 32 per cent copper, they allow $60 per ton on account of the copper alone. From the values thus obtained $15 per ton is deducted for smelting charges When a copper mine containing gold and silver or telluride ores is the subject under consideration, we think it would be prudent to make out our balance-sheet by adding to the charge of $15 the cost of mining, transportation to Argo, etc., and calculate the value on the given standard of 95 per cent of the gross value of the gold and

silver, and $2 per unit for each unit of copper less 2.

We have considered milling and shipping ores together, for we could not show the commercial advantages except by comparison.

There are districts in the United States where ores are in such quantity and so dissimilar in character that we find the free-milling system, chlorination system, and smelting operations carried on extensively within a radius of three miles. This is notably the case at Butte City, Montana, where the ore from the Orphan Girl Mine and others is treated by the free-milling silver process; the ores of the Alice, Moulton, Lexington, etc., mines, by the chlorination process; while the ores of the Anaconda, St. Lawrence, Parrot, etc., mines are treated by the copper-smelting process. Lead ores are notably absent in that district.

The ores which belong to class (*f*) deserve marked attention, for this section has more commercial importance than either (*d*) or (*e*), or both together. Under it we must consider a very large amount, as well

as various kinds, of ore. We may have an ore for which hand-sorting only is necessary, the selected portion being shipped and sold, or treated near the mine, the associated rock being rejected as not containing sufficient mineral to pay for treatment; or we may have first-class ore as above, and the remainder pay by concentration. We may find it necessary to crush and concentrate the entire product of the mine; and often, when a milling process is used near the mine, it will be profitable to first hand-sort the ore, and ship the high-grade to the smelter, because of the greater percentage saved. The ore may be commercially free-milling, but it may pay to concentrate the tailings, or build a crude dam in the watercourse below the mill and allow them to bank up for future use—which is found quite common in practice.

This division of the subject may well be considered under the head of Ore-dressing, which consists of hand-sorting, and concentration, and is one of the most im portant of metallurgical operations.

As the rich streaks of ore in the mines are being exhausted, the owners begin to

look wistfully on their so-called waste dump, and other material previously rejected, wondering if it cannot be made available. A cheaper method than smelting or chlorination is now needed as a preliminary process, and we are brought to a consideration of ore concentration.

This subject is complex, and requires close and careful study of existing methods and machines.

The large number of machines designed and patented for the purpose of concentration show the importance attached to the subject, and, we regret to say, has proved a fruitful source of revenue to the quacks of mining and metallurgy, who add to the difficulty of honest investigation by false representations. Each manufacturer has some one to act as his duly authorized agent, who is in general commercially irresponsible, and who will be found not to be the duly authorized agent if the innocent purchaser should ever raise the question of reimbursement on account of misrepresentation. These agents, and self-styled engineers of mines, will tell very plausible tales, and show on paper the

magnificent results achieved by their concentrators; and, unfortunately, the merit of these different machines is a subject upon which many engineers, deemed competent by the public, are at variance, so that an honest investigation demands that no hearsay evidence be accepted. Nothing short of a rigid comparative test against approved machines, made with the ore under examination, should be satisfactory in examining a new machine.

It is evident that if we wish to secure separately one or more of the elements of a coherent lump of ore made up of intermingled ingredients, the whole mass must be broken up into particles more or less fine (depending on the coarseness in which the part we seek to separate is disseminated through it), after which the separation must be effected by proper sizing, and by the difference in the specific gravity of the elements. After the sizing, the next question is: What medium shall we use to effect the separation? We must decide between water and air. Both are in use, but I believe the air-concentrator is only designed to replace the water machine in

districts where water is scarce or not to be had. I may say, without recommending either method, that the nearer the medium employed approaches the specific gravity of the useless material of the ore, the more effective the concentration. This would seem to be self-evident; for if the medium had just a trifle greater sp. gr. than the worthless material of the ore, while the valuable portion had a greater, the latter would sink to the bottom, while the former would float off with the medium, and our separation would be theoretically perfect. Even in such a case, however, it would not be perfect in practice, as small particles of the valuable material would adhere to the worthless, and thus be carried off. We deem it necessary to give this explanation, because we have heard the advocates of the air-concentrator claim that what the air lacks in specific gravity can be supplied by giving to it the requisite force—which argument is very plausible; but it must be remembered that this force would have to be applied with absolute uniformity over considerable surface. The objection to the ideal case here assumed is raised, that even

if the concentrating medium has a trifle greater specific gravity than the waste which we wish to reject, some of it will nevertheless be carried to the bottom, by adhering to the heavier and more valuable part. This is true, for perfection in practice cannot be reached; but the fault is in our inability to crush so that the cohesion is broken perfectly on the lines of junction between the heavy and light material, and not in the subsequent operation.

If the student wishes to investigate the subject of air and water concentration he will find the Krom air-concentrator the best of that type; but of water-concentrators he will be met at the outset with such machines as these:

Golden Gate Table, Embrey Table, Frue Vanner, Bumping Table with flexible bottom to imitate the pan motion, Rittinger Table, Jigs of one to four compartments, etc., etc.

It is not the purpose of the writer to recommend any machine, although he has a preference amounting to conviction, not based upon theory alone, but substantiated by practice in the field; and if this

preference should appear too plainly in the discussion which follows, he will not deem it necessary to make an apology for it. The agent for each machine will endeavor to show how effectually he can beat any of the others, especially the jig, in rapidity, effectiveness, and economy. It is the right of every agent to show that he can do this; but we nevertheless would suggest to the student to commence with the jig of three compartments. The same principles are employed in all jigs that we ever saw in operation, the model being the Old Hartz jig, upon which the others are simply improvements, so that if the student gives it his attention first, it will be giving age its proper place. Let the principles involved in its construction be studied. Experiment with ore crushed to different sizes, down to the slime jig. we wish to say here, however, that we do not believe a machine has ever been or ever will be constructed that will make a commercial success on the concentration of slimes. Better attempt to save flour-gold: it will be found much easier, and offers a better commercial field. Ask one of these

machine men if he can save slimes? First there is a look of broad astonishment, gradually replaced with a smile full of wisdom, intended to stagger the honest searcher after knowledge, and show him how little he knows; then, with the utmost nonchalance: Oh, that is quite simple: you need only a few —— machines to concentrate slimes or to put in your mill to concentrate the tailings after leaving the outer copper plates, and your flour-gold is saved. You may remind the machine man that if such is the case he can render inestimable service in gold mining, and make millions for himself and the owners of such well-known mines as these: The Broadway Mine, near Butte City, Montana; the Gloster Mine, near Helena; the entire region of the Black Hills, Dakota, where he can operate on the tailings of the famous Homestake, Father de Smet, Deadwood Terra, etc., mines; the Grass Valley Region of California; the Bodie region: in fact, all over the world where there are gold-mines. The free-milling process will not save 50 per cent of the gold in the Broadway; not more

than 60 to 70 per cent of the Gloster; and, even where the gold is called moderately coarse, not more than 75 to 80 per cent.

Or you may ask the machine men, Why not resume the dividends of the great Bonanza Mines, by extracting the gold and silver which has passed off in the tailings? You now think you have discomfitted these men. Their wise smile only broadens and takes on a shade of benevolence on account of your ignorance, and with much condescension you are told that they are simply waiting to sell in certain standard districts a few more machines, where their worth will be proved, after which it will only be necessary to have a corps of clerks to take down orders; and you are confidentially advised that now is the time to leave your order, before the rush comes and the necessity for building new factories arises. We may truthfully say and quietly prove that this picture is but little overdrawn.

Note the effectiveness of the jig with different ores sized by a 4, 10, 20, etc., mesh screen, the cost of them, and the horse power required to concentrate, say,

fifty tons per day. Compare results with any other machine, under the same conditions. Ask the owner of any other machine to deposit sufficient money in a good bank, to pay the expense of a competitive trial if it fails to equal the jig in effectiveness and economy, and note the result. Should you be fortunate enough to find a machine that will do so, you may be assured that you have a good one, and you will be well repaid for the expense and time. The machine men will say these are old-fogy notions. Well, we believe also in the old-fogy doctrine that truth and honesty are good standards of human action. Machines like the jig and the Cornish pump (when we have to contend with much water) are certainly old, which shows at least that they have borne the test of time. For certain work—that is to say, where there is not too much water—steam-pumps are handier and cheaper than the Cornish, but it would be worth making a considerable journey to see machines that would beat the jig and the Cornish pump in their departments. Having selected our machine, then, we only have the ore

to consider. When the rich part is of the same specific gravity as the worthless, concentration is impossible. It is also evident that the closer the approximation to the same specific gravity the more difficult the separation. In many cases sorting alone is applicable. The valuable part of the vein may be well segregated, that is, occur disseminated in moderately large lumps, the remainder being worthless. The one may be brittle, and form slimes to such an extent that machine concentration cannot be successfully employed because of the large percentage of loss in the tailings. Such, for example, are ores containing a fair percentage of gray copper, brittle silver, dark and light ruby-silver ores, tellurides of gold, silver, etc., disseminated in a fine state of division through the gangue. The valuable part sought may have the same or nearly the same specific gravity as the gangue. These facts should be carefully determined in each case. It is more usual to find varying percentages of coarse and fine ore in the matrix, a large percentage of which may be extracted by coarse crushing, sizing, and concentration, what

there is of fine material being neglected if not commercially available. This is common in practice, and can be seen in nearly all extensive mining districts. Refinements in metallurgical operations will not be tolerated long if they do not pay, and they should not be introduced until their practical value has been demonstrated on a fair scale. It will not do to increase the cost of an operation beyond the value of the increased percentage which may be saved. What is sought is net, not gross, value. We will illustrate this by an example, which will also show the great value of ore-dressing in rendering mines commercially productive which otherwise could only be operated at a loss, and yet there is a heavy loss from a chemical standpoint. The truth of the example and the figures assumed will be attested by any experienced mining man who has worked in large productive mining districts for the precious metals.

Assume that we have a silver-lead ore which contains $15 in the precious metals, and 7 per cent lead. The question now is: What shall we do with it? If the ques-

tion was asked of a mining man in this country twenty-five years ago, he would quickly answer: Let it alone. In its present shape we cannot smelt it by itself, for it does not contain sufficient lead. We cannot mill it by the chlorination method, for the lead is not only objectionable for milling purposes but would not pay expenses; and yet, if we have such an ore in sufficient quantity, we have the means wherewith to build up a fine industry. The average saving in concentration will not reach 80 per cent. In special cases 90 per cent may be saved, but it more often falls to 60 per cent. This will depend on the ore and the method. We shall assume an average of 80 per cent. If we concentrate six tons into one, which is about an average, we shall have as an Expense account:

Mining 6 tons @ $2	$12 00
Concentrating 6 tons @ $1.50 (a high estimate)	9 00
Transportation 1 ton concentrates to smelter	7 00
Smelting charges	10 00
Total cost per ton concentrates	$38 00

We now have for the value of the above not of concentrates:

$15 × 6 = $90, total value gold and silver in 6 tons crude ore;

7 per cent × 6 = 42 per cent, amount lead in 6 tons crude ore.

By concentration we save 80 per cent, and we have per ton concentrates:

80 per cent of $90 = $72.00; and 80 per cent of 42 per cent = 33.6 per cent lead, or 673 lbs. lead per ton.

The smelters allow 95 per cent of the assay value of the gold and silver, and 1½ cents per lb. for lead; from which we find the value of our ton of concentrates sold at the smelting-works:

95 per cent of $72 =	$68 40
And 673 lbs. lead @ 1½ cents =	10 10
Total value.....	$78 50
Deducting expenses.....	38 00
Balance, profit per ton concentrates	40 50
" " " " crude ore....	6 75

This is a very good commercial result, which is what we seek; and unless the

chemical results will show an increased profit, as well as saving in the metals, little attention will be paid to it in practice. If the mine owner had his own smelter, and sufficient lead ore could be obtained in his district to supply it, a much higher profit could be made. It is seen, in any event, that ore of the above value is made available by concentration when possible, even though the per cent assumed as saved were considerably reduced; but as ores vary in the percentage which can be saved, as well as gross value, the determination of the zero-point, that is, where there will be neither profit nor loss, is a problem of extreme nicety in practice. We would advise our client to be exceedingly careful when the profit begins to show a tendency toward that point. Careful and intelligent work in the extraction of ore will greatly assist in the subsequent work of dressing, and may in some cases render it unnecessary. The vein may be small, say 12 to 15 in. wide, all of which is ore of good grade. In the operation of mining we must work in about three times that space, so that there will be twice as much coun-

try rock as ore mined. In such a case, the hand-sorting can be done in the mine, so that a car-load as it is brought out will contain nearly all ore or country rock. The same can be done when the vein is large, but the pay ore confined to a narrow and well-defined streak.

FREE-MILLING AND REFRACTORY ORES COMBINED.

The term "free-milling" is used in a commercial sense, for there is probably no case of an absolutely free-milling ore. The nearest approach to one with which the writer is acquainted is the Cable Gold-mine, near Georgetown, Montana, in which even the iron pyrites associated with the ore does not contain gold except in the free state. More often, however, the sulphurets in free-milling gold rock will contain gold that is not free-milling. When they are in sufficient quantity and value, the mill tailings are concentrated, shipped to the nearest smelter, and sold. The consideration of free-milling and refractory silver ores combined is a subject of far more importance. In some mines the free-

milling will be in excess, in others the refractory; often in the same mine we find a body of free-milling ore, and farther on a body of refractory. In general we find all gradations between the extremes, and it is often found necessary to determine which method will give the best commercial result; in this case also, when we find the profit to be about the same or but slightly in favor of the chlorination process, the preference should be given to the free-milling system, because it lessens the amount of the investment. Suppose, for example, that in a given case we find the gross value of the ore to be $30 per ton, and that we can save by free-milling 65 per cent and by chlorination 80 per cent. We shall have

65 per cent of $30 = $19 50
80 " " " " = 24 00

—a difference of $4.50 per ton in favor of the latter for gross production. But how about the commercial comparison? It is well known by practical and observing mill-men, whose services have included the operating of free-milling and chlorination

ores, that in ordinary districts, or indeed even when the district is well-favored, and cheap salt and fuel can be obtained, the difference in the cost of mixing with salt, roasting for chlorination in either the Stetefeldt or White and Howell furnaces, and the repeated handling incident thereto, will fully offset in additional cost the extra saving by process. Consequently the preference should be given to the free-milling method (as is really the case in good practice), except in cases where the ore is becoming more refractory as depth is attained, and all the evidence tends to show that the ore will shortly become so refractory as to necessitate the chlorination method. This will be treated of later.

In many cases 90 per cent may be saved by chlorination and less than 65 per cent by the free-milling process, the former being preferable for commercial purposes as well as for the greater percentage saved. Careful investigation in each case can give us the facts upon which to base an intelligent judgment. An opinion based upon similarity of ore, and the process used for one kind, is not sufficient to justify us in

deciding that the same process should be applied to another. Such an opinion, so founded, is no more than a mere guess, which is a dangerous mode of procedure in small commercial investments, and much more dangerous when the investment of large sums is involved, as would be the case here. A condition which has led to temporary error is well shown by recent experience in Butte City, Montana, where the ore in a number of mines was free-milling on the surface, and sometimes to a depth of 60 to 100 feet, and then became refractory (it must be remembered that these terms are used commercially). The Lexington is a noted case. For some years prior to the sale of that valuable property to the French company by which it is now operated, Judge Davis of Butte, who was then the owner, worked the ore by the free-milling process to a depth of 50 feet or more, after which he became convinced that chlorination would shortly become necessary. The opinion was confirmed during the examination by the experts, pending negotiations for the sale. No deception was used by the judge. He

frankly told the experts that the reason he wished to part with a controlling interest was due to this fact, for the construction of a large chlorination mill is much easier talked of than effected, involving, as it does, such a large outlay. This case shows that a correct opinion cannot be formed on superficial mining: we must go deep enough to feel sure that the ore is not affected by atmospheric agency. If the examination cannot be made at sufficient depth, except at a loss of too much money and time, and the ore is found to be free-milling as deep as we go, yet we have strong doubts that it will remain so as greater depth is attained, we should provide for the contingency by constructing the mill building, in which the free process is to be used, of such dimensions as to admit the introduction of roasters, etc., so that we can pass to the chlorination method, if necessary, at a minimum of expense. Prudence also would suggest that no expensive mill of any kind should be constructed until there is sufficient ore in sight, the net value of which will more than pay its cost. The practice of erecting

expensive mills on an insufficient showing cannot be too severely condemned.

In what precedes we have briefly considered the subject of mines and ores of the precious metals and the metallurgical operations adapted to them. It has been shown that the process must be adapted to the ore, instead of attempting to adapt the ore to the process. There are hundreds of patent and special machines and methods submitted to the mining public, the inventors of which claim to have a panacea for all the ills resulting from base metals and elements in the ore. The careful examiner will reject them as he would the nostrums of a quack, unless their value is shown by a positive and comparative test. No process of merit has ever been rejected: on the contrary, any process or machine possessing superior merit to those in use will be quickly adopted, and found in operation where needed. Many of the agents will tell you, with all the appearance of truth and honesty: "We have so many in use at Aspen, Col.; so many in Butte City, Montana; so many in Wood River, Idaho; and they are giving excellent satisfaction.

[The district named will be so far from your own section that the probability is that you have not been there.] See, here are letters attesting the fact." Letters and testimonials are produced, yet a visit to the districts mentioned will, in ninety-nine cases out of one hundred, show that there is no such machine in use there, and that if there ever was, it will be found on the waste dump. Some of these agents may themselves be deceived, or have told their story so often that they believe in its truth. We must always remember that many ores are easy to concentrate, smelt, or mill, while others are difficult. The frauds of concentration are by far the most numerous, and easy of perpetration; for which reason, as well as its great value commercially, it demands most attention. The agent may submit letters written by men who were honest in the opinion expressed, but who themselves were in error. For example: The valuable part of the ore sought may have a specific gravity of 5, and not form slimes to any serious extent, while the worthless part has only a specific gravity of 2.6. Many of the

machines will effectively concentrate such an ore, while signal failure would result in the attempt to concentrate with the same machines if the relative specific gravities are as 4.5 to 3.7 or 4 to 3. It must also be remembered that the parties who sent the letters and testimonials may have never made a comparative test, or in fact be familiar with any other machine; and that as soon as they acquired the necessary knowledge they would retract their previous testimony. We are particular in calling attention to this matter, because we know that these agents and their machines have been the cause of a large amount of money being wasted by the mining public, and have caused fair enterprises to fail which might otherwise have been productive—yet the loss is put to the debit of mine, and not of machine account. We know of many instances where the substitution of good concentrators for poor ones turned failure to success.

It has been shown that the process must be adapted to the ore. It will be seen from what follows that both are governed

by locality. There is no country in the world in which the operations of mining and the reduction of ores have been carried to such a degree of perfection as in the United States. We are justly proud of our mining and timbering, the square set, etc., being prepared by machinery on the surface and lowered ready for adjustment; of our steam and compressed-air drills, our double-cage system with double floors for hoisting, our surface and wire tramways, and nearly perfect mills and smelting-works; yet this pride, coupled with self-sufficiency, has often led to serious error. No people in the world are so ready to take advantage of this pride as the Mexicans, and Spanish-Americans in general, usually assisted by some American adventurer who may deceive both parties. If the engineer must be careful of the interests of his clients in this country, he must be doubly so when Mexican and South American mines are under consideration. It is wonderful how innocent and simple these people can look as they say to the American or Englishman: "*Tengo la mina grande, pero no maquina.*"—(I have

a great mine, but no machinery). Our pride is immediately touched, for how is it possible for them to mine successfully without machinery? We will see. We may be somewhat surprised that these people, who live so close to us, should know nothing of the refinements which have been introduced into mining and metallurgy in this country during the past twenty-five years. If due weight should be attached to this consideration, and the cause examined, it will often be found that we have over-estimated their ignorance. Too often we are satisfied in advance that we can beat them if they have no machinery, and are startled when we discover (if we ever do) that in many instances our assumption of superiority is not warranted by the facts; and, unfortunately, these facts often remain in obscurity until it is too late to avoid severe financial loss. We will illustrate this by an example.

The city of Pachuca, State of Hidalgo, Mexico, is the centre of the richest and most extensive mineral region in that republic. It is reached in four to five hours by rail from the city of Mexico *via* the Vera

Cruz and Mexico Railroad to Irolo, thence to Pachuca *via* the Hidalgo Narrow-gauge Railroad. We have selected this place for our illustration, because it is so accessible and so important a district that we have no fear of contradiction. We visited the district four years ago, with letters of introduction to the managers of the Real del Monte mines and the Maravias. The ores are treated by the patio process, and the haciendas of the Real del Monte are the largest in the world, the Progresso being next. The ore is crushed dry with Chilian mills, then removed to the patio floor, where the salt and magistral are added. (We should have stated that the Chilian mills are driven by mule-power.) Water is added until the whole mass assumes the consistency of a thick paste, then trampled by mules, guided by a peon who sits on a mule in the centre of the mass. A detailed description of this slow process would be out of place here. It can be found in Phillips' Metallurgy of Gold and Silver, and similar text-books. Suffice it to say, that it is very expensive, even with the advantage of cheap labor.

The superintendent of the Progresso accompanied us in our examination of that hacienda. Conceive the astonishment of an American miner to see every detail of the patio process in operation, and the stamps of a fine modern 40-stamp mill hung up! In connection with the battery, we found the pans, settlers, etc.; in fact, a new and complete chlorination mill. Blank amazement would convey but a poor idea of the manner in which we stared at that mill, which we could see was not in use. The superintendent was eying us sarcastically. We asked why the mill was stopped. He answered with another question: "What do you run your mills with?" We are somewhat surprised, but answer: "Why, water or steam power, of course." Where is the water? How do you produce steam? A light begins to dawn upon us. We looked around, but could see no water, except a small stream blackened and thickened by the mud from the numerous patios above. Even if clean, there was not enough to run two fair-sized mills. This stream is called the Pachuca *River*. (It must have been named during the wet season or the

flood.) Could we obtain even cheap fuel? Glancing around later, from a high hill we found that not a stick of timber was visible. About a mile lower down stream we found the Pachuca River hacienda, which some New Yorkers or Bostonians will doubtless remember, for it cost them 50,000 good American dollars. We found excellent machinery, and a fine assay laboratory, constructed, we were informed, by an American engineer, whose business doubtless was to erect the buildings according to instructions, and not to ask questions. The purpose of this plant was to concentrate the tailings from the haciendas up the stream. Let it be remembered that the patio process is applied to ores similar in character to chlorination ores; that is, dry ores, the precious metals existing in gray copper, brittle silver, light and dark ruby, etc. We are not aware that other than dry Mexican ores have been worked by patio process—certainly not at this date. At all events, the silver ore in the Pachuca district is exceedingly refractory, the valuable constituent of the ore being chiefly brittle silver with a little gray copper, and

more rarely ruby-silver. Furthermore, though slow and expensive, the patio process saves very close—closer indeed than our chlorination; so what could result from an attempt to concentrate such tailings? Nothing but what actually happened. The machinery remains as a monument. We have heard much talk of the feasibility of working over some of the old Mexican dumps by concentration, and some reputable men have even talked of organizing a large company for the purpose, so that though we depart from our general to a specific subject, yet it merits a little attention, for it certainly furnishes food for talk, if not for much thought, carrying us back, as it does, to the traditional mines of Mexico. We will admit that the methods of mining, reduction of ores, etc., were tedious, slow, and expensive in the past; but that has nothing at all to do with the value of the old dumps: their reduction may have cost $60 per ton. No matter. What concerns us is, how much did they lose, and in what condition did they leave it? We have never heard it asserted, nor do we believe

that it has ever been proved, except in the smelting department alone, that we save the precious metals any closer than they did in the past; but we can make a still closer limitation, and say, for the purpose in view, free-milling does not save as close as the old Arastra, and chlorination no closer than the patio. The great improvements made in mining and metallurgy have had for their object commercial considerations, viz.: rapidity and economy. We have never heard of a concentrator being placed after a settler in a chlorination mill. Why, then, should it be successful after the patio?—for it is the tailings from this process it is proposed to concentrate. We know of no large dumps from any other process. There can be but two reasons assigned: either that others than dry ores were submitted to that process, or that it did not work with the same degree of closeness that it does at the present time. Against this we must cite the fact that ore for the patio is pulverized very fine, thus forming a maximum of slimes, which militates against successful concentration, no matter what the

machine men may say. Of course we can only present the probabilities of success or failure; for in a given big dump, such as that of the Vete Grande, near Zacatecas, Mexico, it would be necessary to submit it to a rigid test, first noting the surroundings to see if concentration is at all commercially possible.

The locality of Pachuca renders the patio process a necessity. We see, however, that it was not always customary in Mexico to investigate until the mine was secured—occasionally not until the mill was added. Let us go back to the Mexican "who had a good mine, but no machinery," and go through the usual routine. The man who is seeking a mine asks; "Was your mine ever worked?" "Yes, sir." "Did it pay?" "Yes, sir." "How deep was it worked?" "Three hundred feet." "Why was work stopped?" "The water was too much for us, as we had no pumps." "How did you work your ore?" "Sold it to —— hacienda." "How did they treat it there?" "Patio." "What did they deduct for treatment?" "Thirty dollars per ton." "What did you

pay for miners?" "Three reals [= 37½ cents] per day." "Are they good men?" "If properly directed, yes." "What did you pay for common labor?" "Two reals," [= 25 cents]. "How wide was your vein?" "Six to fifteen feet." "Was all pay ore?" "About one half." "How much will your dump assay?" "About thirty-four dollars per ton." "What will it cost to ship it?" "Nine dollars per ton." If the above answers were given correctly, the mine would certainly appear good enough to justify the expense of a close investigation for honest purposes, for if the surroundings are not too adverse, such a mine ought to pay well with the advantage of cheap labor.

With or without an examination—better without, perhaps—it is good enough for a mining shark, who will simply go to the mine and select samples of the ore, observing whether he may safely state that the vein is as large as represented. In what follows we shall assume a case; but it is selected to fit what has been carried out so often in practice, and with the single exception of a change of scene, will

fit a case which several persons of our acquaintance may recognize. It will also show the character of the most of the stocks listed on the Mining Exchange, operations in which are published, and find their way all over the country, thus doing incalculable damage to our second greatest industry. What benefit the Exchange derives from keeping on their lists securities known to be worthless, is difficult to understand. The Exchange has the name of the Consolidated Mining and Petroleum Exchange. Being ignorant on these matters, we would be pleased to have some light on the definition of the term "mining" from their standpoint. Does mining mean the extraction of elements of commercial value from the ground? And are places where the operation of extraction is performed called mines?

When the operation ceases because there no longer exist elements which can be profitably extracted, is the place still a mine? If a railroad cannot exist without rails, how can a mine exist without ore? Or is a certain piece of paper, representing an interest in a certain piece of ground which

is known to contain no ore-mining, stock? Is a transfer of these pieces of paper to an innocent purchaser legalized under the head of mining-stock when the seller knows the ground to be exhausted of the material which gave it the name of mine? We are becoming so seriously mixed in our definitions, that we would be pleased to learn from the Consolidated Exchange if a piece of coal is still a piece of coal after it has passed through the chemical changes involved in its combustion; and if the piece of ground from which it was taken is still a coal-mine if all the coal has been extracted. It may be answered that no one can tell but that there may be valuable ore there still. True but who can tell when he may be standing on top of a $1000 chunk of gold not more than ten feet under the ground? And in this connection we would ask if it is knowledge, or want of it, that makes a mine. If stock quotations are to be published, where the shares are selling at 3, 8, or 30 cents a share, it is unfortunate that the piece of ground is not stated to be exactly what it is; namely, it was a mine; is not now a mine; but, as no

one can see through the ground, no one can say but that it may become a mine again.

We should like to have the legality of selling a piece of exhausted ground, under the name of mine or mining-stock, tested in the courts. The Mining Exchange might become a source of great benefit to the industry, and not a detriment, if these worthless stocks were carefully weeded out. This is, of course, but an opinion, expressed, by one who knows nothing about the inner working of the Exchange; but many good mining securities would be listed that are now kept away, were it not that the owners fear to associate their property with so much other property that they deem worthless. We will now return to the mining shark. He found his investigation satisfactory, and the assays of the samples showed an average value of $40 per ton; but the average of the dump was considerably less than stated by the owner. But no matter about that. He now collects samples and forwards them to New York, accompanied by the sworn statement of the owner as to the past

value of the ore shipped, the condition of the mine when work was abandoned. His own statement is also sent, in which he shows how valuable such a property would be in the United States, and that if deemed advisable to ship five to ten tons to show the value of the ore, he would do so. The advantage of cheap labor, etc., is set forth to show that the mine can be operated cheaper in Mexico than in the United States. Assays are now made in New York, and the ore is found to go much higher than stated. Any one at all familiar with mining will see that the bait looks very tempting. A few friends decide to take hold of it, and wire Mr. A. in Mexico to secure a bond on the property immediately. Useless waste of money—they might be assured that he already had it. He wires back that he will do the best he can; follows this by a letter saying that he must have $10,000 cash and $40,000 in six months, to satisfy the owner; that six months will give ample time to pump out the mine and put it in paying shape; winding up by advising the immediate

transmission of the $10,000 to bind the bargain. After a conference in New York it is decided to send one of the partners (Mr. B) with the money, and also to see the mine before paying it. On reaching Mexico he is met by A and together they visit an important mining district, where B is shown similar ore to that he saw in New York, under treatment, and he naturally assumes at a good round profit. A points out the crude and imperfect method employed in mining, the slow and expensive method of grinding the ore by the Chili mill; and above all, the terrible patio process is pointed out with mingled feelings of pity and disgust. The mine it is proposed to purchase is now visited. Everything is found to be as stated; contracts are drawn up and signed, the $10,000 paid over, and B is ready to go home. This does not suit A at all. There are other important districts to visit, many historical things to see. They have made an excellent investment, and the visitor can write home, tell what he saw at the mine, etc., and notify the others of the satisfactory conclusion of the business.

Then B can take a week's holiday. It is so arranged. The object of A now is to kill just sufficient time. After spending eight or ten days seeing the sights, A proposes another visit to the mine, where he shows the necessity for a mining pump. After discussing the matter, B decides to take A with him to New York. This is exactly what A wishes. Then they reach Vera Cruz, six weeks have elapsed from the time of signing the papers. Four days are consumed waiting for a steamer. On landing in New York two months have elapsed. B makes no note of the passage of time ; not so with A,—he notes it carefully. Several conferences are now held between all the partners, and A is empowered to select the pump he wishes. He spends a week examining the machine-shops, and finally leaves an order at some foundry for what he wishes. He then visits friends in Chicago, whom he says he has not seen for some years. On his return, he is surprised to learn that the pump has been ready for some time. It has just occurred to him that he must have a machinist, and it takes him a few days

more to find one that will exactly suit him. He is found, however; and the pump and other supplies are put on board the steamer. Three months have elapsed from the time of signing the contracts. The mine is reached with the machinery in three weeks more. Everything is now apparently being done to hasten matters. Barrels are filled with water to supply the boiler; there is not sufficient time for any other kind of arrangement. At the end of the fourth month the pump is in operation. The water yields much more rapidly than was anticipated. The shark is a little disconcerted for the first time. He has to make some purchases in the city of Mexico, and must see the owner about an extension of time. He invites the machinist to go along, remarking that they can finish pumping at any time. He manages to waste two weeks. They return to the mine, and find no perceptible increase of water since they left. At the end of the fifth month a dispatch is received in New York that the mine is pumped dry, and blasting commenced; asking that one of the partners take the next steamer for Mexico, with

authority to draw for the money still due on the mine. Another of the partners (C) starts. As soon as he sees A he asks about an extension of time, who promises to do the best he can, but reports the next day that it is impossible. A hurried trip is made to the mine. The vein is there, and the ore blasted is the same as before seen; some samples are hurriedly taken to the city of Mexico, and assayed, with a result of $35 per ton. The shark has gained his point. There is no time left in which to have a detailed examination and commercial tests made. We have followed the operation of this shark step by step as briefly as possible, for he is only one of a class of men whose methods have been disastrous to many, and who are a serious drawback to the mining industry. They have no faith in any mine, nor would they work a moderately paying one if it was presented to them. Good or bad, their sole effort would be to sell it for as much cash as possible.

There is a totally different class of men who make it their business to seek good property for presentation to capitalists, and

render efficient service to buyer and seller for a fair commission. We shall consider this matter later, and follow the shark along in one of the usual methods. He calls C's attention to figures and data, showing that in the United States with high-priced labor large dividends are made from poorer ore. C thinks it well to consult an engineer. Time is short, so he immediately consults some responsible business man, and asks for information respecting the engineers in the city—their qualifications, honesty, experience, etc. Let us consider the position in which C now finds himself. Within a week he must decide whether he shall pay out the sum of $40,000 or not, which is a sufficiently delicate matter under the most favorable circumstances; but in his position we would like to avoid the responsibility. He is in a strange country: $15,000 has been paid out—$10,000 first payment, and $5000 expenses and improvements. If he refuses to pay the $40,000, this is lost. He now sees that a trustworthy and competent engineer should have been engaged on the start, for he is now dependent on the testimony

of a business man as to the competency and honesty of any engineer within reach; yet how should a business man know anything of the qualifications of an engineer? With respect to this we may say, that on our visit to the city of Mexico four years ago, we found a man posing as an expert mining engineer and, strange as it may appear, he had the best reputation of any engineer in that city for competency; yet we knew him to be discharged less than two years previously for sleeping on his post in a large mill in this country, where he had charge of running the engines on the night-shift. His competency could not be questioned in the new capacity which he assumed, without knowledge of his qualifications; but the transformation to an expert mining engineer in so brief a period argues but poorly for the profession, or bears testimony to extraordinary capacity on the part of the individual. The fact here mentioned does not lessen the difficulty of C; and the chances now are that were it not for the $15,000 already in the mine, he would reject it unless he were allowed sufficient time in which to

select a competent engineer in the United States, send him to examine the property, and report on its value; but under the circumstances he must do the best he can. He consults an engineer,—and we will assume he is one who has more regard for his profession than a fee,—to whom the case is stated. The engineer calculates the time needed to go to the mine and return, which will probably show that he cannot spend more than a day or two at the property. Then he frankly says that it would be useless for him to go, as there is not sufficient time for an examination upon which to base a trustworthy opinion. He is asked what he will charge to go and spend what time there is left. The engineer's fee may be $1000 and expenses. That settles it; he is not needed. The sharp is consulted, and, by his aid, one is found who will go for $100 and expenses, who claims that he can tell all about the property in a day. He is sent. The last hope to avert severe financial loss was rejected with the first engineer; and, when it is too late, the buyer will learn that he was lucky even to find such a man at all, and

threw his chance away when he rejected him, even though his price had been $2500. The report of the quack sent is corroborative as to the great value of the mine, the remaining $40,000 is paid over, and thus the first part of a mining transaction is completed, on evidence that neither of the men who furnished the money would accept in an ordinary business transaction, with which they are familiar, for $500.

Have we now reached the end? Far from it. There are the mine and the ore. What is to be done with them? Prudence now, if ever, would demand the employment of a thorough and painstaking engineer. Will he be employed? Oh no; he is too expensive. The sharp goes to New York with C, and a meeting of all who are interested is called. They decide that the patio process is too slow and expensive. A forty-stamp mill, with chloridizing furnaces, pans, settlers, etc., is agreed upon; but now it is found that assistance must be had, for such a mill erected and in running order will cost $150,000 to $200,000, and perhaps more, unless the mine is located in a section

where there is good mill timber. The reverse is most often the case in Mexico. A stock company is now decided upon, and it is agreed to sell only enough stock to buy and complete the mill. The public now take hold and buy up the stock, assuming that such careful business men as the promoters took every precaution to satisfy themselves as to the value of the enterprise. $100,000 worth of the stock is quickly disposed of, and at a meeting of the trustees called for the purpose it is decided to order the mill at once, feeling assured that the remainder of the stock laid aside for the purpose will be quickly sold. A mill-builder and a superintendent are now engaged. The shark says he does not feel competent to manage an enterprise of such magnitude. The stock set aside to equip the mill is disposed of. It is also found that the entire holding of the shark has been sold. Questioned as to the cause, he says that he is going away for some years, and wishes the money to operate with. Some of the purchasers of stock wish a market for it, and it is decided to put it on the Exchange. The

regular Exchange will not list it, so it goes to the Mining Exchange at, say, $10 per share, par being $50. Many of the boldest operators and their friends open the attack, and sell it short. The more prudent and extensive dealer is not ready yet.

A plain-looking man might be seen buying a ticket for Mexico a few days later. If we happened to be with the party struggling along the road between the railroad terminus and the mine with the machinery, we might see a man coming along on a stout mustang, who bears a strong resemblance to the plain man who bought a ticket in New York nine or ten days before. As he comes up he asks the destination of the machinery, then pulls out a map, scans it rapidly, and asks for information of a place five or six miles from there. A mining expert is certainly on his way to the mine at last, and we may be assured he is one who knows his business. Who sent him? The directors of the newly formed company? Oh no, it would cost too much. Two or three weeks later, five or six of the lesser brokers of the Exchange are offering stock of the newly listed com-

pany for sale in small blocks. A very prominent broker buys in about one quarter of what they are offering, the remainder being taken up by outsiders. The stock gives way and falls a point or two. There is a hurried meeting of the board of directors and some of the other stockholders. The situation is discussed, and the conclusion reached that it is simply a "Bear" raid on the stock, which they resolve to sustain. Under their purchases the stock advances. Larger and larger blocks are offered and taken up, but the stock again breaks. The public take alarm; some of their stock is offered. Lower and lower goes the price. All the stock held by the public is now thrown on the market in a lump at any price. The prudent operator buys it in to cover his short sales. The original promoters go to the rescue again, and the stock is again advanced considerably; but now the prudent man begins his attack anew. The stock breaks again, more large blocks are offered, and the market is further weakened. The promoters and their friends are still buyers, and hold nearly all the stock issued. There is a heavy short

interest, and consequently some danger of a squeeze being given to the sellers. The prudent operator is equal to the emergency. He knows or learns who the principal stockholder is, and calls him to a secret conference, at which the plain-looking man whom we last saw in Mexico appears. Under a pledge of secrecy, a map of the mine is exhibited, also a general map showing the location of the district, etc.

The stockholder now receives the first accurate information he has had. Integrity demands that the information be given to his associates, but the more powerful motive of self-interest says no—not, at least, until he has unloaded his own holding in the concern, which is offered accordingly. His associates continue to buy, in order to obtain all the certificates issued. A shrewd member figures up to see how much more is out, and discovers that there is stock being sold and in the market, which should not be there, unless there is treachery. Investigation leads to the discovery that his most reliable confrère is unloading. He is furious at not being made acquainted with the design. The temptation to beard

him, and show that his treachery is known, naturally follows such righteous indignation. But stay! Should he be made aware of this, he would unload the faster, and thus break the market still more rapidly; furthermore, the other innocent associates would then be liable to find it out and throw their stock on the market also, thus breaking it completely. What would become of his own holding then? Self-interest prompts caution, and the necessity of keeping his own counsel; and it prevails. But partner No. 1 is blamed that he is compelled to hold his knowledge and his purpose to unload from the others. His stock is now offered first slowly, then more rapidly, and further breaks the market. Partner No. 1 is now satisfied that the information given to him has been communicated to others. All the stock he has left is thrown upon the market in a lump, no matter what the price. No. 2 does the same. The end is apparent. In the mean time, what about the mine? Shortly after the collapse of the stock, letters are received from the builder and the superintendent, stating that after great hardship they had

reached the mine with a part of the machinery, but find it is useless to build a mill, as there is not sufficient water in the district, mine water included, to run even a patio process so that the tailings may be carried out of the way, and that water cannot be brought in except at great expense; that the nearest hacienda where ore can be sold is sixty leagues distant; and that the ore, though of lower grade than supposed, is nevertheless of good average quality for a favorable location, but will not pay by any known process located where it is; and winds up by asking for instructions. They are told to return home, which they do, leaving the machinery where it is in the care of a peon. Many will doubt that such an extreme case as this can be reached. If so, let them ask any one who has travelled on the Magdalena River about the heaps of rusting machinery at Calamar, San Martin de Loba, Bodega Central, etc. This mine and its stock would quickly be lost sight of, and sink into oblivion, where it belongs—for those who were fleeced would be ashamed of their part of the transaction, and the public

certainly would not attempt to resurrect it; but it is on the Mining Exchange, and hawked around at five or six cents per share; these quotations are marked up, and printed in the newspapers at these figures—another blow at the mining industry, which is but a cipher in the catalogue of blows dealt in this and other ways; and yet the industry has forged ahead with astonishing rapidity, under the leadership of men who will claim our attention later, until it has reached the distinction of being the second great industry of the republic.

Who was responsible for the tissue of error in the example just shown? Want of men qualified to show that, at the present time, it could not be made a success? It could not be this, for we have the most capable engineers of any country in the world. The mining shark? No: he simply acted the part assigned to him by nature, and might not really know but that the mine would pay; lacking faith in all mines he would naturally sell in any event. A few of the innocent purchasers of stock may ask the promoters who was to blame. "Oh, nobody. We are all heavy losers, and

it serves us right for going into a mining enterprise," is the reply.

The entire operation has been outlined, so that it will not be difficult to fix the blame; but the mine must bear it, for whether a promoter makes or loses money by such transactions, he is sure to assign every failure to the special mine; he thinks, perhaps—and there is not a doubt in our mind that he is right—the mining industry can bear it better than he can.

We have given but two examples of locality governing mines and processes, but I think they are sufficient. Many examples can be found in the United States. We may be working in a district where there is a sufficient amount of wet ore to smelt the dry ore, in which case a chlorination mill would not be erected for the latter; and indeed the dry ore might not be made to pay with such a mill, when it would do so by smelting if we have the wet ore to mix with it. From the prices and percentages saved, previously quoted, this can be readily seen, and does not need an example to illustrate it. This work is but a brief culling from personal experience in

the field. It is not the purpose of the writer to explain to the experienced engineer what his duty to his client should be, for many of them have passed through the same experience as we have attempted here to describe; but we think it covers part of the ground of inquiry which should be made by every young man who designs making mining and metallurgy of the precious metals a study for his future profession. Nor is it the purpose to convey knowledge of specific operations in the departments of mining and metallurgy, which can be found in standard works; but rather to point out some of the difficulties to be met with in the application of the knowledge when acquired, and under what conditions the application may be attempted with some degree of safety.

The special object, however, is to show to the capitalist something of an engineer's duty, and seek his aid in an effort which should be made for the purification of an important profession, and which will have at the same time a strong tendency to check some of the fearful waste of money by bogus mines which has been going on

for the past twenty-five or thirty years Without the aid of the capitalist the engineer can do nothing. The capitalist may or may not employ a competent man; for how is he to tell, when there is no law, except conscience, to prevent any one from calling himself an engineer of mines, and signing his name as such? And yet a careful consideration of the foregoing will show the capitalist that every person may not be intrusted with the performance of the duties described. The chances of error are great enough, without adding the burden of incompetency. "But how will you detect incompetency?" is a question that will be asked when any one may claim to be an engineer of mines, and assert that he is a master in his profession. Certificates of competency are demanded of persons who seek to fill positions far subordinate in importance to that of a mining engineer, for even a managing engineer is under a heavy responsibility for the preservation of life and property. Why not demand from him a certificate of competency, signed by a competent board of examiners, some member of which

will keep a record of easily avoidable errors committed by those to whom certificates are issued, and placed against the name of the person by whom committed, a sufficient number of which will involve a forfeiture of his certificate. This may not eradicate the existing evils, but it will materially assist in doing so. Competency in the profession of a consulting engineer especially requires intelligence and a broad technical education, coupled with practical experience in varied fields, second to no profession in the world. In law and medicine some protection is afforded by statute. A man must be a graduate from some law or medical institution, or pass a rigid examination, before being permitted to practise under protection of law. But a graduate of the School of Mines, Columbia College (the leading institution of its kind in the world), who receives a degree of E.M. authorized by the State of New York, must go into the field and compete with any man who sees fit to sign himself an E.M. and whose chief qualification, in many cases, is that he has spent eight or ten years in one or more mining camps.

His great boast is that he has this experience, but he seldom tells in what capacity. We do not mean by this that a course in college is necessary, for we believe in self-made engineers as much as we do in self made men. Some of the best engineers we ever knew were self-taught; but we never knew them to ascribe their knowledge to the single fact that they spent eight or ten years in a mining camp. Rigid as are the examinations at the School of Mines mentioned, yet the professors will frankly admit that their ablest students have simply the preparatory education necessary for their future development in the field of labor.

A complete exposure of all the evils which retard the development of the mining industry, and of the extensive frauds perpetrated, would fill a volume; so in what follows we will confine ourself to a few of them. Any industry can suffer only by a failure to yield an adequate commercial profit on the capital employed in its prosecution. As applied to mining, the causes of this failure are in individual cases many. We say individual cases, for we do

not think any reading man will, in view of the magnificent results achieved by comparatively few men, who employed their money intelligently and under the management of skilful engineers, say that mining as an industry is a failure. This success has been secured by the employment of less than one fourth of the total amount subscribed in the United States for mining purposes. The men who supplied this one fourth merit the gratitude of all who take an interest in the industry, especially of consulting and managing engineers, for the intelligence and care exhibited in their selection of property and of the men whom they employed in its management. Among these men we may with propriety mention some whose names have only to be heard in any mining community in the United States to give confidence and strength to a mining enterprise in which they may be connected. The great fortunes accumulated by the men, whose names we are about to mention, resulted from their prudence and complete mastery of a complex industry, and not from a single stroke of luck—as was the case

with the men who became enormously wealthy from the Bonanza Mines of the Comstock Lode. Personally we do not know any of the gentlemen whose names are about to be mentioned. We know them only by the results they have achieved, which are matters of history; and it is from this standpoint alone that I take the liberty of using their names.

Haggin & Tevis, with whom George Hearst has been associated, have achieved success in nearly all the various departments of mining heretofore mentioned. In the Black Hills of Dakota they give support to the majority of the people who populate the cities of Deadwood, Lead, and Central—in all, 12,000 to 15,000 souls, with their Homestake, Father De Smet, Deadwood-Terra, Giant, Old Abe, etc., free-milling gold mines; at Park City, Utah, 3000 to 4000, with their Ontario Mine and chlorination mill; at Butte City, Montana, 2000 to 3000, with the Anaconda and St. Lawrence copper-mines, the smelting-works of which, situated in the Deer Lodge Valley, support the city of Anaconda, with its 5000 to 6000 souls. I

might mention other mines and works controlled by these men. The great mills in the Black Hills, Dakota; Parley's Park, Utah; and enormous smelting-works in the Deer Lodge, are the most enduring and valuable monuments which will be associated with the names of these men as the stanch and skilful supporters of a great industry. To what is their phenomenal success due? Rigid preliminary investigation by competent men; the selection of the fittest metallurgical process for each mine; the selection of capable men as managers, whom they bind to themselves by the closest business ties; mutual good faith, the payment to their chief employees of liberal salaries and a part interest in the enterprises to which it is their duty to give thought and energy; and finally, unusual liberality to all their employees, which adds to their sense of duty in rendering faithful service.

It must not be supposed from the above that all the mining enterprises of these gentlemen are successful; but in the manner mentioned, their failures are reduced to a minimum. When they do make a

loss, it is not blazoned on the streets or in the Exchange. They never say, "It serves us right for engaging in a mining enterprise." Their aim is to make their success exceed their failures as much as possible; and with what success, is seen above. Some of the other men who have rendered great and enduring services to the industry are Prof. Hill, of the Argo Works; J. B. Grant, of the Omaha and Grant Smelting Works; Messrs. Billing & Eilers, Gilmer & Saulsbury, and the Walker Bros., of Salt Lake City, Utah. These are chief among the men who formed the bulwark to the mining industry, which has proved impenetrable to the attacks of ignorance, incompetency, jobbery, and fraud.

It is our belief that fully three fourths of the money subscribed for mining purposes is not applied to it, but is paid out in heavy commissions, excessive purchase-price for property and machinery known to be worthless or of doubtful value, excessive purchase-price for property of known value, etc. Each mine is debited with the total cash paid out, no matter how much of it is pocketed by the middlemen

and promoters. We shall briefly mention the chief causes of loss in honest and intelligent mining. It will be seen by the preceding description of ores that they are varied in character and quality, even in the same mine or vein. A mine may pay to a certain depth, and then, by a change in either the character or quality of the ore, fail. A good example is furnished by the Penobscot Mine at Vestal, Montana. It paid very handsomely the discoverer and first owner, Mr. Vestal, who worked one shaft to a depth of 160 feet, and another 750 feet, distant from the first 100 feet. Short levels were also opened at 60 and 100 feet, and the average samples taken from all of them was two ounces free-milling gold ore. In this shape it was purchased at a high price. An excellent mill was erected about a mile distant, and a good tramway connection between mine and mill made. Before a depth of 200 feet was reached, and the levels extended 50 feet in either direction, the ore became commercially worthless. It would not pay the cost of mining and milling. This would convey the idea that

the mine was salted before it was sold. It was not so, however; for it was originally examined by a capable and painstaking engineer, at which time the ore was yielding the amount mentioned by the Arastra. When the writer examined and condemned it, the shaft (main one) was down 300 feet, and the 100-foot drift extended until it connected with the other shaft. There was nothing in the mine at that time which would pay, so that it only represented an expensive prospect; but who could foresee this when it was examined by the first engineer? Who could condemn it at that time? Many of the men who worked in the mine believe that there are good chimneys of ore in it still. Less than five miles distant we now find the town of Marysville. Nine years ago there was nothing on its site but a rude little log-cabin, inhabited by a man whom people called Crazy Tommy Cruse. We will see that there was method in his madness. He was then engaged in driving a tunnel on the side of a very steep hill adjacent to his cabin, and was following up a streak of copper-stained quartz

one to three inches in thickness. With indomitable pluck and perseverance he worked alone, driving his little tunnel forward for two to three years, at the end of which he was rewarded with the famous Drum Lummon vein, twelve to forty feet in width, now the property of the Montana Mining Co., Limited, of London. These two instances (the Penobscot and Drum Lummon) are mining accidents, and very exceptional. Nine years ago, who would have condemned the former and recommended the latter? Yet had it been done, the fortunate man would have been given credit for great wisdom. We have never seen two other such extreme cases as those here mentioned—the one making such a remarkably good showing, and the other so extremely poor; yet the conditions became entirely reversed in a short time. The engineer may be called upon to examine a prospect, and find it good as such. It now becomes necessary to distinguish between professional duty and the desire to take a risk for ourselves, with, perhaps, though not often, one or two friends. We may take a chance on a prospect, if we

wish; but it is too slender a thread upon which to hang professional reputation by recommending it to the public. A vexed question may now be asked, What is the line of demarcation between a prospect and a mine? Personally, we will answer that we would decide as much by the vein as by the development. Its magnitude and character are important considerations. Generally, a piece of property passes from a prospect to a mine when, in the estimation of the person making the examination, sufficient work has been done to show that the chances are largely in favor of permanency in the vein.

Each person will define his own limits, so that the line of demarcation is far from clearly drawn; for what one person may consider a prospect may be pronounced a mine by another.

The ore may be free-milling to a certain depth, and pay until the increased expense of deep-mining or change to a more refractory ore would entail loss. These are some of the causes of unavoidable loss and uncertainty: surely enough of themselves, without the addition of jobbery and fraud,

or the necessity of paying large dividends on a sum representing, very often, ten times the actual cost of the enterprise.

The capitalist is sometimes a serious bar to success. This may seem a strange statement when it is considered that without the necessary capital we are rendered helpless; nevertheless both statements are true. It may be asked, In what sense is he a drawback? Even though he should lose his own money and that of his friends, how does it hurt mining? Money represents accumulated labor, or rather its value. If all the labor in the United States was non-productive, we should have a poor country. The maximum of prosperity is reached when it is all made as productive as possible. The loss of money, therefore, being a loss of labor, is injurious, especially to the industry in which it was sustained, because it is a debit against it; whereas, if intelligently and prudently employed, it might be productive, and the amount be found on the credit side. Does any one suppose that the million or more wasted at Silver Cliff on the mines heretofore mentioned, and others, is no detriment

to the mining industry? Ask any man who sustained part of that loss to invest in a legitimate mining enterprise, and the chances are that he would open his safe, pull out a bundle of Plata Verde, Game Ridge, or other worthless stock, and offer it to you for sale. You reply that you do not want it, as it is worthless. "Very well," he says, "I have enough of such stuff." (We simply mention what we know has happened many times.) By this it is seen that the industry instead of the incapacity or carelessness of those who promote the enterprise is charged with the blame.

What the mining industry needs is a thorough knowledge of its requirements, such as that exhibited by the men whose names have been mentioned. Many capitalists think that mining is easy—that it is only necessary to dig out the ore and sell it; yet these same men will, in their own business, watch every leakage carefully. Tell the merchant, banker, or broker, that to be successful in mining requires as much knowledge and prudence as his own business, and he will eye you in a man-

ner indicating the existence of insane hospitals. Many of them have bought mining interests for the purpose of making an opening for a friend or relative whom they would not trust with their own business, and whom they send to take charge of a business with the requirements and details of which he is entirely ignorant, and so must depend on the faithfulness of men whom they employ. He must ask somebody when a miner is doing a day's work, if the blacksmith sharpens his drills properly, if the carpenter is framing his timbers properly, and if a sufficient amount of timbering is being done for the protection of life and safety to capital. It would seem that brief reflection would show them that success could not be expected under such management; yet when failure comes, as it must, they do not blame themselves or their managers: no, they simply shrug their shoulders, and say, "I took a mining flyer and lost;" and the friends who put in their money will tell you, "I put in some money with my friend in the —— Mine. He sent his cousin out to manage it, so that every-

thing would be level; but it failed, and I will not have anything to do with mining again." We are well aware that such flyers as these are not confined to mining alone; that they are taken in railroad stocks, oil certificates, futures in grain, etc.; and that, though successful at times, the aggregate is a much heavier loss than in mining. These losses, however, are never mentioned outside of a select few. People are supposed to know something of these matters, and a confession of ignorance and loss with respect to them would hardly be wise; but in mining it is different.

The operations of the industry are confined to the mountain regions, and are found exceedingly complicated when knowledge with respect to them is sought; therefore the greater necessity for trained servants, and not men who never saw a mine or mill until they assumed charge. Better start in ordinary commercial business a man who knows neither the wholesale nor retail prices of the goods in which he is to deal, or send a plough for repairs to a harness-shop or a harness to the blacksmith-shop. The loss, at all events, will be less.

One of the most serious evils to mining is the practice of presenting mines to the public at enormous prices. Often an engineer is compelled to condemn a mine because of the price at which it is presented. Many good prospects remain undeveloped for the same reason. It is the favorite field of the mining shark, and it is here where his fangs sink deepest. Every extensive mining camp is infested with these men; nor are they confined to mining districts alone, but may be found in all sections, especially in large business and speculative centres.

Their methods are various, but we shall confine ourself to a few of the most common, but at the same time most effective. The railroad station, which is the outfitting point for the camp, is watched for the arrival of strangers, who are followed to the hotel; their names are learned from the register, and then they are shadowed. No detective in the country has a keener scent than the mining shark. If you seek mines, he will quickly discover that fact, and also the special one which is the object of your mission. His plans are

quickly formed. The mine to be examined may be bonded to another shark, or to a man who honestly seeks to promote the joint interests of owner, buyer, and himself. Shark No. 1 may know the owner, and the person to whom the mine is bonded. If not, he will quickly find them out. His next step is to make the acquaintance of the stranger, with whom he spends as much time as possible, discussing the interests of the camp, most prominent mines, mills, etc., and requests the pleasure of meeting him at his house that evening to meet one or two of the superintendents. His next move is to see the owner of the property, who may have seen him with the stranger. He tells him confidentially that he knows all about the negotiation going on, and that he can aid him very materially, as he knows the examiner well; that they have mutual acquaintances in New York, etc.; and that he is willing to use his influence with him, if it is made an object. The owner tells him it is bonded to shark No. 2. No. 1 says: "Tell me exactly how much you are to get, and it will help matters." The price to

No. 2 is $16,000. No. 1 is thoughtful for a moment, then says: "Well, I don't think he can get much more than that. Now, if I make this thing go through, you can give me $4000." It is so arranged. He next sees No. 2; the same story is told about his intimacy with the stranger, also that he can defeat the sale if he wishes: then he asks No. 2 what his price is. No. 2 tells him that his price to his friend, shark No. 3, in New York, will probably be $30,000. No. 1 now says: "I'll tell you what we will do: you ask $36,000, give me $8000, and we will put this thing through." The proposal is accepted. The shark at the New York end is notified that the bed-rock figure is $36,000, but that in order to make it mutually interesting, No. 3 should ask $50,000, the balance of $14,000 to be divided as follows: $4000 to No. 2 and $10,000 to No. 3. The latter now goes to his New York friend, tells him the bed-rock figure is $50,000, and values his own time and services at $5000, making $55,000. This man adds $10,000 for himself, and at last it reaches the real party who may desire to purchase, or a prominent promoter, at $65,000.

If to the latter, the property is intended for the public. The property may be accepted at $65,000, and a company organized. The cash value of all the stock will be placed at what has been a favorite figure, $400,000, 50 per cent of which will be offered for sale, to pay for a supposed remainder due on the property, and a working capital of $50,000. There will thus be $200,000 − ($65,000 + $50,000) = $85,000 more to be divided. All of this grows out of an actual $12,000 purchase; and we may say here, without the least fear of contradiction, that the case here assumed is not overdrawn. Let us suppose that it was presented to a capitalist, who wished to buy the property on its merits, at $65,000. The engineer has been sent, made his examination, and returns. Nine times out of ten, he will condemn the property at any price; but he may have found a good prospect, and so states. Asked if it is worth $65,000, he says no; that of course he cannot say to what value it might develop. It might do to pay $10,000 for a 51 per cent interest, the money to be expended in developing the property, with the right to

withdraw any money that might be left over, whenever prudence would suggest abandoning the property, or he might recommend its purchase at $12,000 to $15,000. If the capitalist really wants the mine, he must now commence negotiations directly with the owner. But if the property was really bonded to shark No. 2, he will not resign it without being well paid, and thus the negotiation be defeated. The practice of giving long bonds on property to these sharks, who only wish to speculate on the time given them, is to be regretted; yet it is very prevalent in large and good mining districts that attract the notice of capitalists. An engineer is often wearied with these people, and, if he permits it, much of his time will be wasted. It may be asked if they do not attempt to bribe the engineer: possibly so, if he gave the slightest encouragement, but no engineer who merits the name would do so. Some people may court such an offer of bribery in order to condemn a mine. This is mistaken policy, and not to be entertained by any true engineer; for the rascality of the owner, or whoever the

seller may be, does not detract one iota from the mine itself. If the opinion of the seller, or his word, has anything to do with the value of the property, there would be no use for an examiner. The Double-decker Mine of Leadville was sold on the value of salted samples, yet was a very valuable property. It has been shown that the commercial value of a mine depends upon the character of the ore as well as its intrinsic value; and to those who know little of mining, this is by no means apparent: consequently, a very common mode of procedure on the part of the shark is to say: "I have a 6-foot vein of ore that will run $14 per ton. Such and such mines are paying $25,000 per month on $10 ore. Assay certificates are produced to show this, and samples submitted for positive proof. Asked why he does not work the mine, his excuse will be want of capital. Another common method of deception is to use the past history of the mine and the production to show its present value. The operations performed in New York with Leadville mines will doubtless recall this. We have often been called upon

to examine a mine from which the ore was practically exhausted. It was shown by smelters' certificates that the mines did pay; but we find all the available ore extracted, and suggest that the mine is exhausted. "Oh, no," is the reply; "there was not ore enough taken out: on further development you will encounter the same ore-body." No one can see through the rock, and say whether or not such is the case; but its past history is no advantage: on the contrary, it is quite a serious disadvantage; for at best it is but a poor and expensive prospect, and developing, or rather seeking for more ore, in an old mine is much more expensive than in a new prospect. The very history of which advantage is sought to be taken is unfavorable. When applied in a general sense, for mining history shows that the extraction of five tons of ore will exhaust some mines, while 100,000 tons would not exhaust others. The richest lot of free-gold specimens we ever saw were exhibited to us by the cashier, Mr. Halley, of the bank at Rapid City, Dakota, about sev en years ago. They were from the Ben

gal Tiger Mine, which was much talked of there at that time. We asked him if he went to see it, and how much there was of such ore. He showed us a cigar-box about half full of the specimens, and said: "Yes, I went to see it, and bought these—all I could see there." He was right: subsequent work proved that, to all commercial intents and purposes, he had the mine in the cigar-box. A very applicable remark is credited to a Wall Street magnate. He was asked to buy one of the most famous producing mines of Leadville. Smelting returns were shown from the Grant, Burdell Witherell, and Billing & Eilers smelting-works. The ore-books were shown, to prove that the ore extracted yielded six millions in less than four years. The magnate quietly replied that he would buy the mine if so much had not been taken out of it. When a mining enterprise of magnitude is to be investigated, instead of asking the engineer to do it for less than his usual fee, it would be much safer to ask for additional labor devoted to the examination. The soundness of any judgment is to be estimated by the

amount of intelligence and care which produced it. In mining matters specific knowledge must be added. Covering as it does a wide field of inquiry, an engineer's efficiency should be estimated by the amount of his intelligence, prudence, and technical knowledge.

The capable engineer must remember that it is incumbent upon him to keep pace with his profession, and if possible be himself one of those who make the advancing strides. Past and present knowledge accumulated and published in standard works is not sufficient for the progressive engineer. The study of it is most valuable in showing the progressive strides of a great industry. Improvement is the order of the day, and he who does not keep pace with it will fall behind in the race. To condemn a fine property for want of knowledge, is no less an error than the recommendation of a poor one. We must never fear unavoidable error imposed by the conditions of nature. No one can know how soon a mine will be exhausted, when rich chimneys of ore may be en-

countered, or how soon a vein may widen. The examiner has nothing to do with these matters. He is not employed to indulge his imagination, but to determine cold business facts as they exist, and whether or not there are known and improved methods that will certainly alter these facts for the better. In what has preceded, the term *ore* has been used in its customary sense. So applied, it means vein-filling, for in every mining camp the expression: Will this or that ore pay? is used. The correct meaning of the word *ore* is: A substance from which metals or their compounds may be extracted with profit. In this sense we see that what were not ores twenty or twenty-five years ago are so now; that what are not ores to-day may be so four or five years hence, by reason of improved methods, cheaper labor, etc.; and also, what is not an ore to one person at the present day may be so to another, because of his knowledge of superior methods or better business management. Hence the absolute necessity for an engineer to keep pace with the rapid pro-

gress of the times. The present bent of improvement is in the direction of lixiviation, which has for its object the extraction of the most valuable ingredients by the use of a solvent, the worthless part being unaffected by it. If the metal, or metals, which we seek are so chemically combined in the ore that they are not soluble, then they are submitted to a process that will render them so, and the solvent then applied. Such are the subsidiary processes of Augustine & Ziesvogel, already mentioned. The usual solvents used in lixiviation are water, salt, and hyposulphite solutions. Lixiviation is by no means new; but we doubt if the application of solvents for cheapening metallurgical operations has been sufficiently investigated. It is evident, however, that though lixiviation may be used successfully in one district, it may fail in another. In lixiviation by salt (brine solution), or by the Von Potiva method with hyposulphite of soda, these materials must not be too expensive to purchase or produce.

In the preparation of the foregoing, we

have not consulted a single text-book, and have had no regard for fear or favor (perhaps too little). Imperfect as we know it to be, it is nevertheless based upon the stern facts taught by an extensive field practice.

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